Kinoform Hard X-ray Optics with Sub-micron Resolution

Beamline: X13B

Technique: Hard X-ray

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Publication:
K. Evans-Lutterodt, J.M. Ablett, A. Stein *et al*., "Single Element Elliptical Hard X-ray Micro-Optics," Optics Express, **11** (8), 919-926 (2003).

Motivation: For an ideal optic, the limiting resolution in the far-field, is of order the wavelength of the incident radiation. For hard x-ray photons, with wavelengths of the order of 1Å, the limited availability of high quality optical elements has hindered the development of imaging and focused spot applications. In particular, high efficiency optics are necessary to observe biological systems in-vivo. Kinoforms are computer generated phase optics, which upon illumination, generate an image of the mathematically desired object. One key feature of kinoforms is that they can yield efficiencies of 100% into the desired image. In comparison, a loss-less binary phase zone plate the maximum diffracted intensity into the 1st order focal spot is 40.4%, compared with a 100% for loss-less kinoform lens.

Results: We have fabricated and tested kinoform optics and have obtained resolutions at 11.3KeV as good as 0.6 microns, with efficiencies as high as 60%. Shown to the left is a typical knife edge measurement.

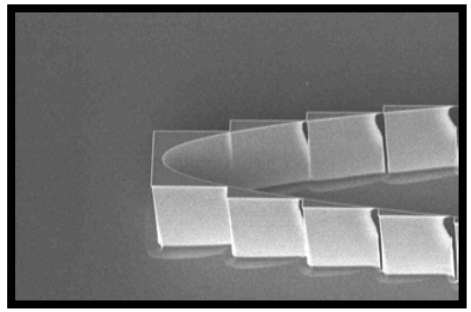

Figure 1. A typical kinoform Fresnel lens of the type described here. Fabricated out of silicon, with deep reactive ion etching techniques, these have been etched as deep as 80microns. The optic is a linear focusing element.

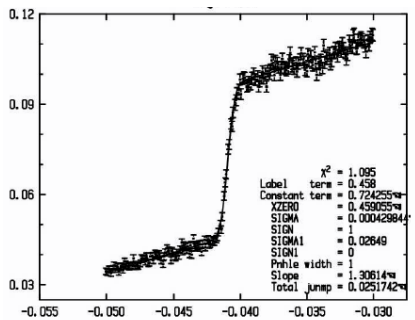

Figure 2: A typical knife edge measurement using a fluorescence from a 1 micron thin deposited copper film deposited on a silicon substrate.